



Department of Land and Natural Resources
COMMISSION ON WATER RESOURCE MANAGEMENT

HAWAII

Well Construction

& Pump Installation

STANDARDS

Honolulu, Hawaii
January 1997



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FOREWORD

About 50 percent of Hawaii's water supply comes from ground-water sources. Ground water, which is also used for agricultural, industrial, and domestic purposes, is the principal source of municipal water supplies in Hawaii. Consequently, protecting the quality of ground water throughout the State is essential to Hawaii's future well being.

Improperly and inadequately constructed wells can cause pollution of ground-water sources to the point of requiring cessation of use or expensive treatment before use. The Hawaii State Water Code and the Administrative Rules of the Department of Land and Natural Resources require the Commission on Water Resource Management to develop minimum standards for the construction, modification, repair/maintenance, and sealing/abandonment of wells in order to protect the quality of Hawaii's ground-water resources.

The State Department of Health and County water supply departments also play a critical role in maintaining drinking water sources and protecting ground-water quality. Consequently, these government agencies may have adopted or may adopt in the future more stringent standards for wells than are provided in these state-wide minimum standards.

ACKNOWLEDGMENT

This report was prepared after consideration of all comments and suggestions from private parties and public agencies. Private parties included individuals, well drillers, water users, and consultants. Public agencies included County water departments, State Department of Health, and State Department of Land and Natural Resources (Land Division).

Many comments and suggestions were received orally at public hearings and in writing and the Commission on Water Resource Management wishes to thank all for their time and effort during the review process.

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Part 1.

GENERAL PROVISIONS

Part 1.

GENERAL PROVISIONS

Section 1.1 Purpose and Scope

These Standards shall be known as the **Hawaii Well Construction and Pump Installation Standards** of the Department of Land and Natural Resources and are referred to hereinafter as the "Standards."

These Standards establish minimum requirements for the purpose of protecting and preventing the pollution, contamination, and wasting of ground water in the State of Hawaii in the course of:

- Construction of wells,
- Modification of wells,
- Abandonment and permanent sealing of wells and test borings, and
- Installation and repair of pumps.

These Standards apply to all wells constructed for the purpose of locating, exploring, monitoring, developing, injecting, or recharging of ground-water aquifers. However, only Part 3, "Well Abandonment/Sealing" of these Standards apply to test borings (temporary excavations or drilled holes whose purpose is the immediate determination of hydrologic or soil conditions at a site).

These minimum Standards do not preclude other enforcing agencies, state or county, from establishing more stringent standards to meet their objectives.

Section 1.2 Authority

These Standards fulfill Hawaii Administrative Rules 168-14 and Section 174C-86 of the State Water Code (Hawaii Revised Statutes) which read as follows:

"§174C-86 Well Construction and Pump Installation Standards.

(a) The commission shall adopt minimum standards for the construction of wells and the installation of pumps and pumping

equipment. The standards shall be such as to ensure the safe and sanitary maintenance and operation of wells, the prevention of waste, and the prevention of contamination of the waters. The minimum standards for well construction shall include the criteria for well location and the procedures for grouting, sealing, capping, and plugging wells. They shall also provide for the installation of devices to measure the amount of ground water being withdrawn from the wells. The minimum standards for the installation of pumps and pumping equipment shall include the required equipment characteristics and construction.

(b) If any well construction or pump installation standard is violated and as a consequence ground water is wasted or any well is contaminated, the commission, after giving notice of the defect to the owner of the land on which the well is located and giving such owner a reasonable time to correct the defect, may itself correct the defect and charge the land owner for the cost of such correction. Such cost constitutes a lien on the land until paid. The lien may be foreclosed in any court of competent jurisdiction, and in such foreclosure suit the court shall allow the commission reasonable attorney's fees."

Section 1.3 Standards of Other Agencies

(a) New Drinking Water Wells

In addition to the requirements of these minimum Standards, all wells to be used to supply a public water system must meet the requirements of the State Department of Health, Safe Drinking Water Branch, under their rules, Title 11, Chapter 20, entitled "Rules Relating to Potable Water Systems" and as may be amended.

In addition to the requirements of these minimum Standards, all wells to be used by the Water Departments of the respective Counties of the State of Hawaii shall meet their standards specified in Volume I, Part III, Section 5, "Water System Standards, State of Hawaii," 1985, and as may be amended.

(b) Injection Wells

In addition to the requirements of these minimum Standards, the location, construction, and operation of injection wells must meet the permit requirements of the State Department of Health, Safe Drinking Water Branch under their rules, Chapter 11-23, "Underground Injection Control." The commission does not require a permit for the construction and operation of injection wells, but the owner or operator of an injection well must notify the commission by submitting a copy of the injection well permit approved by the Department of Health.

(c) Geothermal Wells

In addition to these minimum Standards, geothermal wells must meet the permit requirements of the Department of Land and Natural Resources, Land Division under their rules, Title 13, Chapter 183, "Rules on Leasing and Drilling of Geothermal Resources." The commission does not require a permit for geothermal wells, but the owner or operator of a geothermal well must notify the commission by submitting a copy of the geothermal well permit approved by the Land Division of the Department of Land and Natural Resources.

(d) Test Borings

The commission does not require a permit for temporary test borings. However, test borings related to underground storage tanks and environmental monitoring or remediation must meet the requirements of the State Department of Health. However, test borings which are permanent in nature for long-term monitoring of water levels and chlorides are considered monitoring wells which require a well construction permit from the commission.

Section 1.4 Definitions

The following definitions shall apply in the interpretation of these Standards: "Abandoned well" means any well whose use has been permanently discontinued. Any well shall be deemed abandoned which has been allowed to become unsealed, leaking, polluting, deteriorating in quality, uncontrollable, buried, or which is in

such a state of disrepair that continued use for the purpose of obtaining ground water is impracticable or unsafe.

"Annular seal" means the grouted length of annular space between casing and the wall of the drilled or otherwise constructed hole.

"Annular space" means the space between the casing in a well and the wall of the hole or between two concentric strings of well casing.

"ANSI" means the American National Standards Institute.

"Aquifer" means a body of rock that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells.

"Artesian well" means a well in which the water rises above the top of the aquifer, whether or not it flows out at the land surface.

"ASTM" means the American Society for Testing and Materials.

"AWWA" means the American Water Works Association.

"Basal aquifer" means an aquifer in which a body of ground water floats on a body of salt water in accordance with the buoyant density difference of the two bodies of water. As a general rule, each foot of ground water above mean sea level is supported by 40 feet of ground water below mean sea level.

"Chairperson" means the chairperson of the commission on water resource management.

"Commission" means the commission on water resource management.

"Enforcing agency" means a state or county governmental agency duly authorized to administer and enforce laws or rules pertaining to the construction, alteration, maintenance, operation, and closure of wells in Hawaii.

"FDA" means the United States Food and Drug Administration

"Geothermal well" means any well constructed for the location, exploration, monitoring, development, or injection of geothermal resources or the natural heat of the earth, the energy which may be extracted from the natural heat in whatever form found below the surface of the earth as defined by Chapter 182-1, HRS.

"Ground water" means any water found beneath the surface of the earth, whether in perched supply, dike confined, flowing, or percolating in underground channels or streams, under artesian pressure or not, or otherwise.

"Grout" means a neat cement or sand-cement slurry used to seal any part of a well.

"Head" means the elevation in feet above mean sea level of the water level in a well or aquifer.

"High-level aquifer" means an aquifer in which a body of ground water is maintained at a higher level above mean sea level than that which can be explained by the buoyant density difference of ground water and salt water. Geologic structures, such as volcanic dikes or poorly permeable formations, generally play a key role in high-level occurrence of ground water.

"Injection well" means any well used or intended to be used for the subsurface disposal of any substance or material which flows or moves whether semi-solid, liquid, or gas.

"Installation of pumps and pumping equipment" means the placement and preparation for operation of pumps and pumping equipment, including all construction involved in making entrance to the well, and establishing seals and repairs to existing installations.

"Monitor well" means any well drilled for the purpose of monitoring ground-water levels, quality of ground water, or concentrations of contaminants in ground water occurring in the saturated zone.

"Potable water well" means any well that taps a fresh or brackish aquifer for potable water use.

"Public water system" means a system for the provision to the public of piped water for human consumption, if such system has at least fifteen service connections or regularly serves an average of at least twenty-five individuals daily at least sixty days out of the year. Such term includes (1) any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system, and (2) any collection or pretreatment storage facilities not under such control which are used primarily

in connection with such system [Ref: Chapter 11-20, Hawaii Administrative Rules, "Potable Water Systems].

"Pump installation" means the installation, replacement, or repairs of any equipment and appurtenances utilized or intended for use in withdrawing or obtaining water from a water source.

"Pump installation contractor" means any person licensed in the State of Hawaii to install, replace, or repair pumps and pumping equipment.

"Pumps and pumping equipment" means all equipment and appurtenances utilized or intended for use in withdrawing or obtaining ground water. It includes seals, tanks, fittings, measuring devices, and controls.

"Repairs" means any replacement, change, or modification of any well, pump or pumping equipment. Customary or normal maintenance is not included in this definition.

"Test boring" means any temporary excavation or temporary small diameter drilled hole whose purpose is the immediate determination of subsurface geologic, hydrologic, or contaminated conditions usually, but not always, in the unsaturated zone above the ground-water level. This definition includes borings for foundation, underground storage tanks, and hazardous water remediation.

"USDA" means the United States Department of Agriculture.

"Water well" means any well, water development shaft, or tunnel being used, intended to be used, or capable of being used to withdraw ground water or any well, water development shaft, or tunnel to be constructed for the purpose of investigating, exploring, testing, or development of ground water.

"Water management area" means a geographic area which has been designated for management of the ground or surface-water resource therein, as provided in Chapter 13-171, "Designation and Regulation of Water Management Areas."

"Well" means any excavation or opening into the ground, or an artificial enlargement of a natural opening drilled, tunneled, dug, or otherwise constructed for the location, exploration, monitoring, development, injection, or recharge of ground water and by which ground water is drawn or is capable of being withdrawn or made to flow.

"Well construction" means the drilling, tunneling, digging or otherwise constructing a well for whatever purpose, including any alteration or repairs of an existing well, but excluding the installation of pumps and pumping equipment.

"Well driller" means any person licensed in the State of Hawaii to construct, modify, or repair wells.

Section 1.5 Exemptions from Unusual Conditions

Although the Standards presented herein are considered adequate for the prevention of contamination and waste of ground water throughout the State of Hawaii, if the commission finds that compliance with any of the requirements of these Standards is impractical or will not provide adequate protection of ground-water quality because of unusual local conditions or circumstances, a variance may be requested and the commission may waive compliance and prescribe alternative requirements which will prevent contamination and waste of ground water in a manner otherwise equal to these Standards.

Section 1.6 Well Drillers and Contractors

All work required in the construction, modification, or sealing of wells shall be performed by well drillers (with a C-57 license) or general contractors (with a C license) licensed by the Hawaii Department of Commerce and Consumer Affairs, Division of Professional and Vocational Licensing.

All work required in the installation of pumps and pumping equipment shall be performed by well drillers with a C-57 license, pump installers with a C-57a license, or general contractors with an A license.

Section 1.7 Permits Required

In the State of Hawaii, work on water wells and monitor wells requires a well construction permit from the commission; work on injection wells requires a permit from the State Department of Health; and work on geothermal wells requires a permit from the Department of Land and Natural Resources, Land Division. Work on test borings does not require a permit, but all test borings should be sealed with neat cement before abandonment. The various permits required, the enforcing agency, and the applicable standards are summarized in Table 1, "Well Permits and Reports Required."

Applicants for well construction (includes modification), pump installation, and water use permits issued by the commission, should check with the commission for the latest updated form.

Section 1.8 Reports Required

Reports relating to construction, modification, and abandonment of water wells and monitor wells are required to be filed with the commission as provided in the appropriate sections of these Standards. Reports for injection and geothermal wells are required to be filed with the corresponding enforcing agency (see Table 1).

Persons filing a well completion report, well abandonment/sealing report, or pumping test record required by the commission should check with the commission for the latest updated form.

Section 1.9 Exclusions

The requirements in Part 2, "Well Construction" of these Standards do not apply to temporary test borings. However, the requirements of Part 3, "Well Abandonment/Sealing" do apply to all test borings.

Table 1. WELL PERMITS AND REPORTS REQUIRED

Well Type	Proposed Activity	Permit Requirements			Applicable Well Standards
		Permit	Report	Enforcing Agency	
Water Well (fresh, brackish, & salt water)	Drill new well. Modify existing well. Redrill existing well. Deepen existing well. Relocate incomplete well. Abandon/seal existing well.	Well Construction	Well completion report. Well abandonment/sealing report.	Commission	These Standards
	Install new pump. Modify existing pump. Replace existing pump.	Pump Installation	Well completion report.	Commission	These Standards
Monitor Well	Drill new well. Abandon/seal existing well.	Well Construction	Well completion report.	Commission	These Standards
Injection Well	Construct; Operate; Abandon/Seal.	Underground Injection Control (UIC)	Refer to Chap. 11-23, HAR	State Department of Health	These Standards and Chapter 11-23, HAR
Geothermal Well	Drill; Modify; Modify use; Abandon/seal.	Geothermal	Refer to Chap. 13-183, HAR	State Department of Land & Natural Resources	These Standards and Chapter 13-183, HAR
Test Boring (temporary)	Excavate/drill. Abandon/seal.	None	None	None	None

Note: New wells to be used to supply a public water system must meet the requirements of Chapter 11-20, entitled, "Rules Relating to Potable Water Systems" of the State Department of Health. Test borings related to UIC and environmental monitoring or remediation are subject to the State Department of Health.
HAR = Hawaii Administrative Rule.

Part 2.

WELL CONSTRUCTION

Part 2.

WELL CONSTRUCTION

Section 2.1 Well Construction Permits

No well, except injection, geothermal, and temporary test boring type wells shall be constructed, modified, repaired, or abandoned and sealed without a well construction permit approved by the chairperson. Injection wells and geothermal wells require permits from other state agencies (see Table 1 of these Standards). Temporary test borings do not require a well construction permit. Permanent test borings for hydrologic monitoring of water levels and/or water quality are considered monitor wells which require a well construction permit. Wells for withdrawal purposes in commission-designated water management areas require a water use permit approved by the commission prior to well construction permit approval. An application for a well construction permit shall be accompanied by a non-refundable filing fee, excepting government agencies, and shall be required for all areas of the state.

Applications for a well construction permit shall be made on forms provided by the commission. A fully completed application shall be approved or disapproved within 90 calendar days of receipt. Each application shall contain the name of well owner or operator; well location; preliminary elevation; well driller's license number; purpose of proposed construction; proposed withdrawal and use of water; water use permit information, if applicable; type, size, and expected capacity of the well; and such other information as the commission may require on the form provided.

A well construction permit may be issued only if the proposed construction complies with all applicable laws, rules, and standards. Before an application for a well construction permit is approved, the chairperson will consult with the Department of Health for compliance with their rules and standards concerning, among other things, the appropriateness of the well location.

Every permit for construction or modification of a water supply well shall require a pumping test, if none has been performed. Measurements of time, pumping rate, drawdown, chloride content, and temperature shall be recorded and reported as required in these Standards.

Every well construction permit shall require the well driller to file a well completion report. The permit shall be prominently displayed at the site of the well at all times until the well construction is completed.

The holder of a well construction permit, with the approval of the chairperson, may change the location of the well before or after start of construction. A written request to change the location shall state the location, proposed depth, method of construction, size, and expected capacity of the new well. The request to change the location shall also state the manner of sealing or plugging the abandoned well if applicable. The chairperson may consult with the Department of Health for compliance with their rules and standards concerning, among other things, the appropriateness of the location of the well.

An amended well construction permit may be issued by the chairperson if it is determined that the proposed new well location will serve the same use as the original well, draw upon the same supply of water, and will not be contrary to any applicable law, rule, order, or regulation; and that the incomplete and abandoned well will be sealed or plugged in an approved manner.

Any applicant for a well construction permit whose application is rejected or amended by the chairperson may obtain a hearing before the commission by filing within 30 days of the mailing of the notice of a rejected or amended application, a written petition requesting such a hearing. The hearing shall be conducted as provided in Chapter 13-167, "Rules of Practice and Procedure for the Commission on Water Resource Management."

The commission may modify, suspend, or revoke a permit, after notice and hearing, on any of the following grounds:

1. Material misstatement or misrepresentation in the application for a permit.
2. Failure to comply with the provisions set forth in the permit.

3. Willful disregard or violation of any provision of this part or any rule adopted pursuant thereto.
4. Material change of circumstances or conditions existing at the time the permit was issued.

Every well construction permit issued shall be for a specified period not to exceed two years, unless otherwise specified in the permit and shall contain the commencement and completion dates for the permitted activity. In determining the commencement and completion dates of the activity, the chairperson shall take into consideration the following:

1. Cost and magnitude of the project.
2. Engineering and physical features involved.
3. Existing conditions.
4. Public interest affected.

The chairperson may extend the completion date of the activity prescribed in the well construction permit upon a showing of good cause and good-faith performance. If the commencement or completion date is not complied with, the permittee shall be notified by certified mail that the permit is to be revoked by the commission within 60 days of the notice, unless the permittee can show good cause that it should not be revoked.

Section 2.2 Well Depth

Except for salt-water wells, any well constructed in basal aquifers for the purpose of nonpotable or potable water withdrawal shall be initially designed and pump tested at a depth below sea level not exceeding one-fourth of the theoretical thickness (41 times the head) of the basal ground-water body, unless authorized by the chairperson. Upon request by the applicant and submission of an analysis of preliminary yield, drawdown, and chloride data prepared by a qualified ground-water geologist, hydrologist, or engineer, the chairperson may allow deepening and subsequent testing of such wells to a depth below sea level not exceeding one-half of

the theoretical thickness of the basal ground-water body. The chairperson may request a statement of qualifications of the preparer of the analysis.

Section 2.3 Well Location

(a) General

Wells shall be located so that they are minimally exposed to known potential sources of pollutants and permanently accessible for modification, repair, maintenance, and abandonment/sealing. When avoidable, wells shall not be located in flood, drainage, or runoff areas. Relief from the requirements for well location may be granted by the enforcing agency when unusual conditions exist at the well site.

(b) Distance from Sources of Pollution

As a guideline, wells to be constructed for potable water use should be located a minimum horizontal distance from known or suspected sources of pollutants as indicated in Table 2. On a case-by-case basis, the chairperson may increase or decrease the distances shown in Table 2 based on local geologic or hydrologic conditions.

The location of monitor wells and nonpotable water wells are exempt from the minimum distance requirements listed in Table 2. The location of injection wells are subject to the requirements of Chapter 11-23, "Underground Injection Control" of the State Department of Health.

Table 2. Minimum Distances for Potable Water Wells

Source of Pollution	Minimum Horizontal Distance from Pollution Source
Any sewer line	50 feet
Cesspool, septic tank, or subsurface sewage leaching field	1000 feet
Hazardous waste landfills and ponds, or chemical storage	1000 feet
Treated effluent injection well	1/4 mile

(c) Gradients (slopes)

Where possible, wells shall be located hydraulically up-gradient (normally on a higher slope) from potential sources of pollution. Consideration should also be given to the fact that pumping a well may cause a localized reversal of the existing ground-water gradient due to drawdown of the ground-water table.

(d) Flood and Drainage Areas

Potable water wells located in flood and drainage areas should have well casing terminated above the 100-year level of flooding, as shown on the latest FEMA (Federal Emergency Management Agency) map and be properly designed to avoid potential contamination of the aquifer from flood waters. If necessary, the immediate area around a potable water well should be built up so that drainage moves away from the well.

(e) Accessibility

All wells shall be located an adequate distance from buildings and other structures to allow permanent access for well modification, maintenance, repair, and abandonment/sealing, unless otherwise approved by the enforcing agency.

Section 2.4 Well Casing

(a) General

Wells which are to be used for water supply, monitoring, or injection shall be constructed with well casing adequate to maintain the structural integrity and intended use of the well and to maintain the natural pre-existing state of protection of the ground-water aquifer from pollution or contamination. Well casing shall be strong enough to resist the forces imposed upon it during and after installation. Steel is the material most frequently used for casing wells in Hawaii. Casing standards apply only to permanent well casing and not to casing installed temporarily for construction purposes.

(b) Diameter of Casing

The diameter of casings for water supply wells shall be of sufficient diameter to receive a pump assembly of sufficient size to discharge the planned pumping capacity. The minimum casing diameter for water wells shall conform to Table 3 and the water well standards of AWWA publication ANSI/AWWA A100-90, as may be amended. The casing diameter of monitor wells and injection wells shall meet the requirement of the well owner and Chapter 11-23 of the State Department of Health, respectively.

Table 3. Minimum Casing Diameters for Water Supply Wells

Maximum Outside Diameter of Pump Assembly (inches)	Minimum Inside Diameter of Well Casing (inches)
4	5
5	6
6	8
8	10
10	12
12	14
14	16
16	18
18	20
20	22

Reference: ANSI/AWWA A100-90

(c) Wall Thickness of Casing

The wall thickness of well casing shall be selected in accordance with good design practices applied with due consideration to conditions at the site of the well and shall be sufficient to withstand anticipated formation and hydrostatic pressures imposed on the casing during its installation, grouting, well development, and use. The minimum wall thickness of carbon-steel casings in wells shall conform to Table 4 and the AWWA standards for water wells (ANSI/AWWA A100-90), as may be amended.

The wall thickness for steel casing in county water supply wells shall be as listed in Table 5 and "Water System Standards," State of Hawaii, 1985, Vol. I, p. 258, as may be amended.

Table 4. Minimum Wall Thickness for Non-County Water Supply Wells

Depth of Casing (ft)	MINIMUM WALL THICKNESS (in fractions of an inch)									
	Nominal Casing Diameter in inches:									
	8	10	12	14	16	18	20	22	24	30
0-100	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16
100-200	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16
200-300	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	3/8
300-400	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	3/8	3/8
400-600	1/4	1/4	1/4	1/4	5/16	5/16	5/16	3/8	3/8	7/16
600-800	1/4	1/4	1/4	5/16	5/16	5/16	3/8	3/8	3/8	7/16
800-1000	1/4	1/4	1/4	5/16	5/16	5/16	3/8	7/16	7/16	1/2
1000-1500	1/4	5/16	5/16	5/16	3/8	3/8	3/8	7/16		
1500-2000	1/4	5/16	5/16	5/16	3/8	3/8	7/16	7/16		

Reference: ANSI/AWWA A100-90

Table 5. Minimum Wall Thickness for County Water Supply Wells

Nominal Diameter (inches)	Wall Thickness (inches)
2	0.154
2-1/2	0.203
3	0.216
3-1/2	0.226
4	0.237
6-8	0.280
10	0.322
12	0.365
14	0.375
16	0.375
18	0.375
20	0.375
22	0.500
24	0.500
26	0.500

(d) Minimum Length of Solid Casing

All wells (excepting salt-water wells, artesian wells, and temporary monitor wells designed for immediate or short-term monitoring purposes and subsequent abandonment/sealing) shall be constructed with a casing string having a minimum length of solid casing equal to 90 percent of the depth measured from the ground surface to the top of the selected aquifer, less 10%. A section of perforated or screen casing may or may not be included at the bottom of the solid casing string. Minimum length of solid casing for salt water wells shall be through the entire fresh and brackish water portion of the lens.

(e) Casing Materials

(1) *Steel*. All water wells shall be cased with new steel casing conforming to one of the manufacturing standards listed in Table 6 and in the standards of AWWA publication ANSI/AWWA A100-90, as may be amended. The physical properties of the steel shall conform to ASTM A-242, ASTM A53, Type E or S, Grade B, or approved equal. The well casing shall be manufactured in accordance with applicable sections of ASTM A139, as may be amended.

Table 6. Water Well Casing Materials

Manufacturing Standards for Carbon-Steel Well Casing:
ANSI/AWWA C200 API Spec. 5L ASTM A53 ASTM A139

(2) *Stainless Steel*. Stainless steel casing for wells shall meet the provisions of ASTM A409, "Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service," and any revision. Stainless steel casing for monitor wells shall meet the provisions of ASTM A312,

"Standard Specifications for Seamless and Welded Austenitic Stainless Steel Pipe," and any revision.

(3) *Plastic and Thermoset Plastic (Fiberglass)*. Except as determined by the chairperson on a case-by-case basis, plastic casing shall not be used in wells where well depth exceeds 100 feet or where cement grouting requirements may distort or collapse the plastic casing or where drilling tools are contemplated to be used to re-enter the well following installation of the casing.

Except for possible contamination by organic solvents or petroleum products, thermoplastics or thermoset plastics are acceptable materials for plastic well casing. Thermoplastics are plastics which can be softened with the application of heat. Therefore, one should consider and be careful of the effects of heat generated by the setting and curing of solvent cement. Thermoplastics used for well casing include ABS (acrylonitrile butadiene styrene) and PVC (poly vinyl chloride).

Thermoplastic well casing shall meet the requirements of ASTM F480, "Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80", and any revision. (*Note:* A "dimension ratio" is the ratio of pipe diameter to pipe wall thickness.) Pipe made in Schedule 40 and 80 wall thicknesses and pipe designated according to certain pressure classifications are listed in ASTM F480, as well as casing specials referencing the following ASTM standards and any revision:

ABS Pipe. ASTM D1527, "Standard Specifications for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80."

PVC Pipe. ASTM D1785, "Standard Specifications for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120."

Pressure-Rated PVC Pipe. ASTM D2241, "Standard Specifications for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)."

Thermoplastic well casing that may be subject to significant impact stress during or after installation shall meet or exceed the requirements for impact resistance classification set forth in Section 6.5 of ASTM F480. Casing that may be subject to significant impact forces includes, but is not limited to, casing that is installed in large diameter, deep boreholes and casing through which drilling tools pass following installation of the casing in a borehole.

Thermoset plastics cannot be reformed after heating. The molecules become set during manufacture as a result of heat and/or chemical reactions. The most common thermoset plastic used for well casing is fiberglass. Thermoset casing material shall meet the following standards, as applicable, and any revision:

Filament Wound Resin Pipe. ASTM D2996, "Standard Specification for Filament Wound Reinforced Thermosetting Resin Pipe."

Centrifugally Cast Resin Pipe. ASTM D2997, "Standard Specification for Centrifugally Cast Reinforced Thermosetting Resin Pipe."

Reinforced Plastic Mortar Pressure Pipe. ASTM D3517, "Standard Specification for Reinforced Plastic Mortar Pressure Pipe."

Glass Fiber Reinforced Resin Pressure Pipe. AWWA C950, "AWWA Standard for Glass-Fiber-Reinforced Thermosetting-Resin Pressure Pipe."

Fluorocarbon casing materials are generally considered immune to chemical attack and, consequently, are used in certain monitor well applications. Materials include fluorinated ethylene propylene (FEP) and polytetra fluorethylene (PTFE). Fluorocarbon casing materials shall meet the following standards and any subsequent revision:

ASTM D3296, Standard Specifications for PTFE Tubing.

ASTM D3296, Standard Specifications for FEP-Fluorocarbon Tube.

(f) **Casing Joints**

Steel casing may be joined by welds, threads, threaded couplings, or combination thereof. Welding shall be accomplished in accordance with the standards of the American Welding Society or the most recent revision of the American Society of Mechanical Engineers Boiler Construction Code. Casing joints shall be of the types listed in Table 7 and in AWWA publication ANSI/AWWA A100-90, as may be amended.

Table 7. Well Casing Joint Standards

Casing Material	Type of Joint	Standard
Steel	Welded or threaded	AWWA C206
Plastic	Threaded or solvent-welded	ASTM F480

Plastic casing may be joined by solvent welding or mechanically joined by threads or other means, depending on the type of material and its fabrication. Solvent cement used for solvent welding shall meet specifications for the type of plastic casing used and shall be applied in accordance with solvent and casing manufacturer instructions. Particular attention shall be given to instructions pertaining to required setting time for joints to develop strength.

The following standards for solvent cements and joints for PVC casing shall be met, including any revision:

ASTM D2564, "Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Pipe and Fittings."

ASTM D2855, "Standard Practice for Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings."

Plastic casing or screen shall not be subjected to excessive stress during installation and shall not be driven into place. Care shall be taken to insure that plastic

casing and joints are not subjected to excessive heat from cement-based sealing material.

Section 2.5 Rock or Gravel Packing the Annular Space

(a) General

Most water wells in Hawaii are drilled in stable, hard rock strata consisting of fresh to partly weathered basaltic lava flows. Consequently, rock or gravel packing the aquifer section of a well may not be required to stabilize the walls of a drilled hole. In general, rock packing the aquifer section tends to decrease the specific capacity of a well in highly permeable basalt and limestone formations. However, rock packing the annular space may be used where unconsolidated fine-grained volcanics or coastal sediments occur.

(b) Rock or Gravel Packing Materials

Rock or gravel packing may consist of locally produced crushed basaltic aggregate or, preferably, commercially available smooth, water-worn, rounded gravel. Such rock or gravel packing material shall be obtained from clean, non-contaminated sources and shall be inert. Handling and storage of the rock or gravel packing material at the well site shall be such that it remains free of contaminants and debris until placed in the annular space and shall be disinfected by drenching with a 100 mg/l chlorine solution, see Section 2-8(a), just before placement in the well.

Section 2.6 Grouting the Annular Space

(a) General

The space between the well casing and the wall of the drilled hole is called the "annular space." The reason that the annular space of all wells must be sealed with grout from the ground surface to a minimum specified depth is to prevent the downward passage of poor quality water, pollutants, or contaminants from surface sources and subsurface sources in the unsaturated zone above the aquifer. Other

reasons for grouting the annular space are to prevent corrosion of steel casing and stabilize the wall of the drilled hole, or to prevent vertical movement of water along casing in a saturated zone (e.g. salt-water wells).

(b) Conductor Casing

Conductor casing (often called conductor pipe) is sometimes installed on a temporary basis to stabilize the near-surface part of the drilled hole during well construction. However, any conductor casing intended to be permanent or having a length of more than 30 feet must be installed with a grouted annular space having a minimum thickness of three inches to prevent surface contamination of the well. Conductor casings installed without a grouted annular space must be removed in a manner that will permit complete grouting of the annular space between the permanent well casing and drilled hole to the ground surface.

(c) Minimum Depth of Grouted Annular Space

To prevent surface contamination, the annular space of all cased non-artesian wells (except monitor wells designed for immediate and short-term monitoring purposes and subsequent abandonment) must be sealed with grout from the ground surface to a minimum depth of 500 feet or 70% of the vertical distance between the ground surface and the top of the aquifer selected for exploration, long-term monitoring, or development, whichever depth is less. Artesian wells shall be considered on a case-by-case basis. Salt-water wells shall be grouted through the entire fresh and brackish portion of the basal lens.

(d) Minimum Thickness of Grouted Annular Space

The annular space of wells to be grouted must be a minimum of three inches all around the casing to permit effective placement of grout with a tremie pipe having a minimum diameter of 1¼ inches. Should casing with collars be used, the drilled hole shall be increased to provide a minimum three-inch annular space at the collars.

(e) Grouting Materials for Annular Sealing

The grouting materials commonly used to seal the annular space of wells in Hawaii include neat cement or a mixture of sand and cement.

Drill cuttings or drilling mud shall not be used for any part of the grout material. Neat cement used to grout wells shall conform to the requirements of ASTM C150 for Portland Cement, Type I. Special cement-setting accelerators and retardants and other additives may be used, if necessary. Such additives shall meet the requirements of ASTM C494, "Standard Specifications for Chemical Admixtures for Concrete", and any revision. Sand used for sand-cement grouting of the annular space by tremie pipe shall conform to "concrete sand," 100% passing 3/8-inch screen and 2 to 10% passing No. 200 sieve (ASTM C-33), or "masonry sand," 100% passing No. 4 sieve and 0 to 10% passing No. 200 sieve (ASTM C-144).

(1) *Sand-Cement Grout.* Sand-cement for grouting shall be mixed at a ratio of not more than one part sand to one part cement, by weight, and not more than six gallons of potable water per sack of cement.

(2) *Neat Cement Grout.* Neat cement for grouting shall be mixed at a ratio of one 94-pound sack of Portland cement to not more than six gallons of potable water.

(f) Placement of the Annular Grout

The annular space shall be grouted as soon as possible after installation of the casing. In order to ensure successful grouting of the annular space, the grout material shall be installed by pumping or gravity-flowing it through a 1¼-inch minimum diameter grout pipe placed so as to prevent inclusion of foreign materials, or bridging, dilution or separation of grout materials. In order to minimize bridging and plugging of the pipe, the grout pipe should be flushed with potable water before the introduction of the grout slurry.

Placing the grout in the annular space may be done in stages with time allowed for the grout to set between stages so as to prevent distortion or collapse of the casing by heat or pressure. After each stage, the grout pipe shall be pulled up a safe

distance to avoid any possibility of the grout pipe being accidentally frozen in solid grout.

Grouting the annular space may be accomplished by freefall placement if the annular space to be grouted is no deeper than 30 feet below ground surface and is in the unsaturated zone above the ground-water level.

Section 2.7 Well Development

Development or redevelopment of a well shall be performed with care so as to prevent damage to the well and casing. Development and redevelopment operations shall be performed with special care where a well has been constructed in an area of known or suspected pollution or contamination.

Water, sediment, or waste removed by well development or re-development operations shall be disposed of in accordance with applicable federal, state, and county requirements. The enforcing agency shall be contacted concerning the proper disposal of waste from development operations.

Section 2.8 Well Disinfection

(a) General

All non-artesian water supply wells for potable use or tapping aquifers having a chloride concentration of less than 250 milligrams per liter shall be disinfected with the proper amount of chlorine following the completion of any work, including pump installation and repair and well abandonment. The purpose of disinfection is to mitigate the introduction of pathogens into the aquifer.

A 100 mg/l chlorine solution can be prepared by mixing 0.7 quart of sodium hypochlorite (common household bleach, containing 5% available chlorine) with 100 gallons of water or by mixing 2¼ ounces of dry calcium hypochlorite (commonly used in swimming pools, containing 70% available chlorine) with 100 gallons of water.

(b) Disinfection of Well Casing

The inside wall of the casing of all such newly constructed wells shall be thoroughly disinfected by applying with a hose or sprayer a dilute chlorine solution with a minimum concentration of 100 milligrams per liter (mg/l) uniformly around the inside of the casing. Sufficient solution must be used to wet and disinfect the entire length of casing from the top to the ground-water level. The casing shall be thoroughly flushed with potable water for 30 minutes or more after application.

(c) Disinfection of Aquifer Section

The aquifer section of all wells described in Section 2-8(a) shall be disinfected by using sodium or calcium hypochlorite. Depending upon the situation, the chlorine shall be placed and thoroughly mixed in the aquifer by pouring directly, using a bailer, using the rotary drill pipe, or using the test pump, as appropriate. Mixing shall be accomplished by running the bailer or drill pipe up and down the aquifer three or four times, or gently pump surging, as the case may be. The chlorine solution shall be allowed to remain in the well overnight or at least eight hours, except for emergency situations when water is needed without delay. A minimum contact time of 30 minutes shall be provided for emergency situations.

Sufficient chlorine shall be placed in the well to obtain a chlorine concentration of at least 100 mg/l when mixed with the volume of water in the drilled hole. The amount of liquid sodium hypochlorite (common household bleach) or dry calcium hypochlorite (used in swimming pools) to be used for well disinfection depends upon the diameter of the drilled hole and the depth of aquifer penetration and may be determined from the information in Table 8, "Chlorine Required for Well Disinfection."

(d) Disinfection of Permanent Pump and Pumping Equipment

All permanent pumps and pumping equipment to be installed in wells described in Section 2-8(a) shall be disinfected by drenching or spraying with a 100 mg/l chlorine solution, see Section 2-8(a), just before placement in the well.

Table 8. Chlorine Required for Well Disinfection*

Drilled Hole Diameter (inches)	Unit Volume of Water in Well (gals/lin. ft.)	CHLORINE REQUIRED/LINEAL FOOT OF AQUIFER	
		Sodium Hypochlorite, household bleach, 5% available chlorine (Quarts/lin. ft.)	Calcium Hypochlorite, dry granule, 70% available chlorine (Ounces/lin. ft.)
4	0.66	0.0046	0.0148
5	1.04	0.0073	0.0233
6	1.50	0.0105	0.0336
8	2.61	0.0183	0.0585
10	4.08	0.0286	0.0914
12	5.88	0.0411	0.1317
14	8.00	0.0560	0.1792
16	10.44	0.0731	0.2338
18	13.22	0.0925	0.2961
20	16.32	0.1142	0.3656
24	23.51	0.1646	0.5266

* To obtain chlorine concentration of 100 mg/l in the drilled hole.

2.9 Minimum Well Testing

(a) Purpose

Well testing is required when new wells are drilled or when existing wells are modified and have not been previously tested in accordance with the provisions of these Standards. Well testing shall normally consist of a short step-drawdown test and a long-term constant-rate test. Well testing is not mandatory for monitor wells. The purpose of well testing in the prescribed manner is to obtain hydrologic information needed to determine the well's performance and efficiency with regard to yield and drawdown; the well's trend with regard to drawdown, recovery, and salinity; and the nearby hydraulic properties of the aquifer.

(b) Step-Drawdown Tests

Step-drawdown tests are required to establish the efficiency of the well and to provide preliminary information on the yield, drawdown, and salinity (chloride

content) of the well. Step-drawdown tests are not required for wells proposed for production of less than 100,000 gallons per day or 70 gallons per minute. The water level in the pumped well shall be measured at 15-minute intervals for 45 minutes prior to the initiation of the step-drawdown test in order to verify the pre-test static water levels. The step-drawdown test shall consist of pumping the well at progressively increasing fractions of the maximum discharge capacity proposed by the permittee or determined during well development. The minimum length of time for each discharge rate shall be one-half hour and the minimum number of discharge rates shall be 3, depending upon the maximum discharge capacity and the occurrence of observable changes in pumping water levels from one pumping rate to the next. The step-drawdown test shall begin with the lowest pumping rate and conclude with the highest rate. Pumping shall be continuous throughout the entire step-drawdown test. As a minimum, a water sample taken at the end of the test shall be tested for chloride content.

(c) Constant-Rate Tests

Constant-rate tests are required on all wells intended for production of ground water to determine the hydraulic properties of the aquifer, to identify any nearby hydrologic boundaries such as dikes in wells located in confined and semi-confined aquifers, or to determine any trend in salinity (chloride content) in wells located in aquifers affected by salt-water intrusion. The constant-rate test shall not commence until the water level in the pumped well has fully recovered from the step-drawdown test. Prior to the start of the constant-rate test, the static water level in the pumped well shall be measured at 15-minute intervals for 45 minutes.

The pumping rate for the constant-rate test shall be an amount as determined by the results of the step-drawdown test or equal to the pump capacity proposed by the well owner/operator. Constant-rate tests shall be pumped continuously for a minimum period of time, as shown in Table 9.

Table 9. Minimum Test Period for Constant Rate Tests

Proposed Use of Well	Proposed Capacity (gpm)	Minimum Test Period (hours)
Non-County Water Supply	0 - 50	0
	51 - 100	8
	101 - 300	24
	301 - 700	48
	701 - 1000	72
	1001 +	96
County Water Supply		96

The water discharged from a well during constant-rate tests shall be transported to a distance sufficient to prevent the pumped water from reaching the ground-water table and affecting the test results and shall be discharged in a manner that meets best management practices to eliminate erosion.

(d) Accuracy of Measurements

The rate of pumping shall be recorded in gallons per minute (gpm) and shall be maintained within ± 30 gpm or ± 10 percent of the designated rate, whichever is less. The depth to water shall be measured as accurately as possible, but in no case less accurate than to the nearest one-tenth of a foot. Time shall be measured as accurately as possible, but in no case less accurate than to the nearest minute. In observation wells, accuracy of measurement shall be no less than one-hundredth of a foot.

(e) Frequency of Measurements

For constant-rate tests, the depth to water in the pumped well shall be measured at intervals of ten (10) minutes or less during the first two hours of pumping, at intervals of one hour or less thereafter to the 24th hour, and at an interval of two (2) hours or less for the remainder of the required constant-rate test period. Immediately upon termination of the constant-rate test, the depth to water in the pumped well shall be measured at a frequency that corresponds to the pattern required during the pumping period and for such a period of time required for the water level in the well to recover

to within eighty (80) percent of the water level observed at the beginning of the constant-rate test. If recovery to within 80 percent takes longer than four hours, the interval of time for measuring the depth to water in the well may be adjusted as necessary to determine the trend to full recovery.

(f) Pumping Test Records and Reports

Within 30 days after completion of the step-drawdown and constant-rate pumping tests, the well driller shall file with the commission the following:

(1) *Step-Drawdown Pumping Test Record* (on forms provided by the commission or copy thereof). The record shall include the as-built well depths and other dimensions, date and time of measurements, pumping rates, drawdowns, temperature, and salinity (chlorides) of water samples taken.

(2) *Constant-Rate Pumping Test Record* (on forms provided by the commission or copy thereof). The record shall include the as-built well depths and other dimensions, date and time of measurements, pumping rates, drawdowns, temperature, and salinity (chloride concentration) of water samples taken.

(g) Water Quality Analyses Report

Within 60 days after water sampling or 30 days after laboratory results are received, the well owner or operator shall file with the commission the dates and results of any elective water quality analyses performed on water samples taken during the constant-rate pumping test. The results of any analyses for drinking water standards shall also be submitted.

Section 2.10 Well Completion

(a) General

Wells must be adequately protected at all times during and after construction to prevent the entrance of surface water runoff, pollutants, and contaminants; unauthorized access; and damage to the well. All non-producing wells, including water wells which are commonly not put into production until several years after construction, must be completed with the casing extended a minimum of two (2) feet above the ground surface and capped in a manner that will prevent unauthorized entry or any pollutants from entering the well. Such wells shall conform to the following:

(1) *Lockable Cover*. The top of the well casing shall be cut smooth and straight with a lockable cover to prevent unauthorized access and prevent a safety hazard to humans and animals. The cover shall be weather and vermin proof.

(2) *Casing Cap*. Alternatively, the top of the well casing may be capped with a welded steel plate or solvent-welded plastic cap (for plastic casings) fitted with a 1½-inch minimum diameter threaded cap or plug which cannot be easily opened with small or light tools. Openings or passages for probing, venting, cables, or discharge tubing shall be protected against entry of surface water, pollutants, contaminants, and vermin.

(3) *Flooding*. The top of the well casing should terminate above ground surface and known levels of flooding, except where site conditions, such as vehicular traffic, will not allow.

(4) *Concrete Base*. Unless otherwise approved by the enforcing agency, a concrete base shall be constructed around the well casing at ground surface in contact with the annular grout seal. The base shall be at least four inches thick and shall slope slightly to drain away from the well casing. The base shall extend at least two feet laterally in all directions from the outside of the well casing. The concrete base shall be free of cracks, voids, and other significant defects likely to prevent water tightness. Contacts between the base and the annular grout seal, and the base and the well casing

must be water tight. An accurate elevation benchmark shall be clearly established on the concrete base.

(5) *Well Pits or Vaults.* The use of well pits, vaults, or equivalent features to house the top of a potable water well below ground surface must be avoided, if possible, because of their susceptibility to the entrance of surface water runoff, contaminants and pollutants. Well pits or vaults can only be used with approval of the chairperson.

The vault shall contact the annular grout seal in a manner to form a watertight and structurally sound connection. Contacts between the vault and the annular seal, and the vault and the well casing shall not cause the failure of the well casing or annular seal.

The space between the walls of the vault and the excavation into which it is placed shall be grouted to form a seal and structurally sound foundation for the vault.

The vault cover or lid shall be watertight but shall allow the venting of gases. The lid shall be fitted with a security device to prevent unauthorized access. The outside of the lid shall be clearly and permanently labeled as to the type of well. The vault and its lid shall be strong enough to support vehicular traffic where such traffic might occur. The top of the vault shall be set at or above grade so that drainage is away from the vault. The top of the well casing contained within the vault shall be protected with a cover so that surface water, contaminants, and pollutants that may enter the vault will not enter the well casing. The cover shall be provided with a pressure relief or venting device for gases.

(6) *Protection from Vehicles.* Protective steel posts, or the equivalent, shall be installed around a monitoring well where it is terminated above ground surface in areas of vehicular traffic. The posts shall be easily seen and shall protect the well from vehicular impact.

(7) *Paint and Markings.* The well shall be permanently marked by attaching an engraved plate showing the well's assigned State well number and the casing painted so as to be easily visible, located, and identified in the field.

(b) Well Completion Report and Records

Within 60 days after the completion of the construction, modification, or repair of a well (excepting injection and geothermal wells), the applicant shall file with the commission, as appropriate, the following:

1. For all wells, a well construction report (Part I of Well Completion Report form provided by the commission).
2. For all permanent pumps, a pump installation report (Part II of Well Completion Report form provided by the commission).

Part 3.

WELL ABANDONMENT/SEALING

Part 3.

WELL ABANDONMENT/SEALING

Section 3.1 General

All wells and test borings as defined in these Standards must be properly abandoned and permanently sealed to protect the ground-water resources of the State of Hawaii from contamination and waste and to protect public health and safety, whenever:

1. Their purpose has been served, or
2. Their use has been permanently discontinued, and
3. Their physical condition is causing or threatening contamination, deterioration in quality, or waste of ground-water resources, or
4. Their state of disrepair makes their continued use impractical or creates a hazard to public health or safety.

The objective of permanently sealing a well or test boring before abandonment is to restore the geological and hydrological conditions that existed before the well or test boring was constructed, taking into account any changes which may have occurred since the time of construction. (For example, a well which may have originally produced potable water, but which now produces nonpotable water.) The well casing must be removed if such removal is necessary to accomplish the objective. However, if the casing cannot be readily removed, the blank casing above the aquifer must be perforated to allow grouting of the annular space. Permanent sealing of a well shall be accomplished by grouting with a tremie pipe from bottom to top.

Abandonment and permanent sealing of a well requires a permit from the commission. A permit is not required for abandonment/sealing of test borings. All well abandonment and sealing shall be performed by a licensed well driller (with a C-57 license) or general contractor (with a C license). A detailed record of the abandonment and sealing of all wells must be maintained by the well driller or general contractor for future reference and demonstration that the well was properly sealed. A

well abandonment/sealing report must be filed with the commission within 60 days after completion of the work.

The commission shall be notified before work on abandonment and sealing begins.

Section 3.2 Responsibility for Abandonment/Sealing

The responsibility and cost for voluntary or involuntary abandonment/sealing of a well rests with the well owner or operator. The owner or operator of a well to be abandoned and sealed shall not commence with the required remedial work until an application has been made and a well construction permit has been approved by the chairperson.

Within 30 days after completion of the required work, the owner shall file with the commission a well abandonment/sealing report on forms provided by the commission. Information required includes the owner's name and address; the water use permit number, if any; the name and address of the well driller or contractor who performed the work; the reason for abandonment; a complete description of the work performed; and such other information as the commission may require.

Section 3.3 Determination of Abandonment/Sealing

(a) Declaration by Well Owner or Operator

The owner or operator of a well may voluntarily seek abandonment/sealing of a well by first submitting an application for a well construction permit on forms provided by the commission. The application shall include the reason for abandonment and a description of the proposed procedure and work to be performed.

(b) Declaration by Commission

The Commission may declare that a well is abandoned and shall notify the owner or operator that it must be permanently sealed if it finds:

- (1) That the well has served its purpose, or
- (2) That the use of the well has been permanently discontinued, and

- (3) That the well is not being properly maintained, or
- (4) That the physical condition of the well is causing a waste of ground water or is impairing or threatens to impair the quality of the ground-water resources, or
- (5) That the well is in such a state of disrepair that its continued use is impractical or it is a hazard to public health or safety.

Section 3.4 Grouting Materials for Permanent Sealing

Grouting material acceptable for use to permanently seal wells and test borings is either neat cement or sand-cement.

Sand used for sand-cement grout shall conform to "Masonry Sand", ASTM-C-144 or 100% passing No. 4 sieve and 0 to 10% passing No. 200 sieve. Cement used for neat cement and sand-cement grout shall conform to the requirements of ASTM C150 for Portland Cement, Type I.

(1) *Sand-Cement Grout.* Sand-cement for grouting shall be mixed at a ratio of not more than one part sand to one part cement, by weight, and not more than six gallons of water per sack of cement.

(2) *Neat Cement Grout.* Neat cement shall be mixed at a ratio of one 94-pound sack of Portland cement to not more than six gallons of potable water.

Section 3.5 Preliminary Work

(a) Wells in General

Wells which are to be abandoned and permanently sealed shall be investigated by studying existing well records and verifying the physical conditions and as-built dimensions of the well. Such wells shall be sounded with a bailer or other appropriate tool to check and clear the well of any obstructions, undesirable debris or cavein material, oil from an oil-lubricated pump, or other pollutants which could interfere with a satisfactory well seal. Depending upon the situation, such wells may

also be probed with a magnet, video camera, caliper log, or other well tools to determine depths, dimensions, and conditions of the well casing and artesian leakage.

All equipment, loose casing, foreign materials, and obstructions which may interfere with sealing operations must be removed from the well, if possible. Any casing and conductor pipe not removed from the well must be cut off at least two feet below the ground surface and the remaining hole filled with material appropriate to the site or grouted with cement-based material, if in hard rock.

The chairperson shall be notified as soon as possible if pollutants or contaminants are known, discovered, or suspected to be present in the to-be-abandoned and sealed well.

After the well has been properly cleaned and prepared for sealing, the commission shall be notified before sealing operations begin.

(b) Wells in Polluted or Contaminated Areas

(1) *Properly Cased Wells.* Cased wells constructed with a grouted annular space conforming to these Standards shall be prepared for sealing as provided in Section 3.5(a), "Wells in General."

(2) *Improperly Cased Wells.* Cased wells constructed without a grouted annular space conforming to these Standards shall be prepared for sealing as provided in Section 3.5(a) and additionally by perforating the ungrouted section of solid casing. The solid casing shall be sufficiently perforated so that the annular space can be sealed with grout and not serve as a path for surface and subsurface source of pollutants and contaminants to move down the well to the aquifer. The perforated solid casing and annular space shall be grouted with neat cement in a manner conforming to these Standards.

Section 3.6 Sealing the Aquifer Section of a Well

(a) Open Hole Section

After the preliminary work of abandonment and sealing has been completed, the well must be grouted as soon as possible from bottom to top beginning with the open hole section, if any, of the well.

The open hole section of the well shall be grouted with sand-cement slurry by pumping or gravity-flowing it through a 1¼-inch minimum diameter grout pipe. The bottom of the grout pipe shall be placed at the bottom of the well and flushed with potable water immediately before the introduction of the sand-cement slurry so as to minimize bridging or clogging of the pipe. The bottom of the grout pipe shall be withdrawn in stages as the open hole becomes filled, but shall extend into the slurry column while the grout is being placed so as to prevent inclusion of cavein or foreign material, bridging, dilution or separation of grout materials. The grouting of the well may be probed for effectiveness with the grout pipe or, if more practical, with a suitable probe attached to a light-weight cable.

If an interval of open hole occurs in cavernous or highly fractured formations which causes excessive loss of sand-cement slurry, No. 4 crushed aggregate (conforming to ASTM 10M) or concrete sand (conforming to ASTM C-33) may be used to fill such intervals of loss, before continuing to grout with sand-cement.

Optionally, neat cement slurry may be used to grout the open hole section, particularly if the open hole is in low permeability formations.

(b) Perforated Casing Section

After the open hole section of the well has been grouted, the perforated casing section of the well shall next be sealed with neat cement placed from bottom to top with a tremie pipe in a manner conforming to the grouting of the open hole section. However, if the perforated casing section occurs in highly fractured or cavernous formations which causes an excessive loss of neat cement slurry, a mixture of sand and cement conforming to the standards for permanent sealing may be used to fill such

intervals of loss before continuing the sealing of the perforated casing section with neat cement.

Section 3.7 Sealing the Solid Casing Section of a Well

(a) Properly Grouted Wells

The solid casing section of a well with a properly grouted annular space may be sealed with sand-cement grout in one continuous operation from bottom to the ground surface. The grout must be placed with a 1¼-inch minimum diameter grout pipe in a manner conforming to these Standards.

(b) Improperly Grouted Wells

If a well has no record of having a properly grouted annular space and poses a significant threat of surface contamination of an underlying potable aquifer or waste of artesian ground water, the solid casing must be perforated before grouting begins. The solid casing section shall be sealed with neat cement in one continuous operation from bottom to ground surface using a 1¼-inch minimum diameter grout pipe in a manner conforming to these Standards. If an interval of the solid casing section cannot be filled after placement of a reasonable amount of neat cement slurry, sand-cement grout conforming to the standards for permanent sealing may be used to fill such interval before continuing the sealing of the blank casing section with neat cement.

Section 3.8 Special Provisions for Artesian Wells

(a) General

Many artesian wells in Hawaii are old and probably have a deteriorated, leaking casing. Consequently, such artesian wells must be abandoned and permanently sealed if found to be leaking, wasting ground water, or not in use. Artesian wells have the same purpose, objectives, and requirements of the abandonment and sealing of wells in general, but usually require more thorough investigation of the physical condition of the well and any possible artesian flow or leakage in the well before

satisfactory grouting can be accomplished to assure that hydrogeologic conditions that existed before the well was constructed are restored, taking into account changes which may have occurred since the time of construction.

(b) Preliminary Work

In addition to the preliminary work required for wells in general and described elsewhere in these Standards, artesian wells to be abandoned must be investigated to determine the occurrence, depths and magnitude of any ground-water leakage from the aquifer upward into overlying strata through well casing which has been perforated by corrosion and whose annular space has not been properly grouted. A video or caliper log of the well may be required in such cases, especially if leakage may interfere with proper sealing of the well. An assessment of well conditions and proposed sealing procedures shall be discussed with the commission staff before sealing operations are started. The assessment may include a survey of water levels in adjacent wells, a video log, or a vertical flow meter log to confirm whether or not an artesian well is leaking.

(c) Sealing Procedures

Before placement of grout to permanently seal an artesian well, any flow or leakage in the well must be stopped or reduced so that the confining strata above the artesian aquifer can be effectively sealed with neat cement or sand-cement grout. (Neat cement tends to run away in a flowing artesian well.) The well driller may propose and use, after consultation with the commission staff, various methods to reduce or stop the artesian flow or leakage, such as the placement of temporary casing.

For example, if the artesian flow is occurring from the open hole section of the well, placement of large rounded cobbles followed by lesser size cobbles and crushed aggregate, or placement of specially formed concrete cylinders may significantly reduce flow in the well. Packers with grout pipe extending below the packer may also be effective in sealing the open hole section.

Once flow from the artesian aquifer has been stopped or significantly reduced, the solid casing may have to be perforated (see Sec. 3.7.b) before grouting the

remaining part of the artesian well with sand-cement slurry. Placing or pumping the sand-cement slurry at a high rate through a minimum of 1¼-inch or larger diameter grout pipe may be required to successfully complete the sealing operation, if artesian leakage continues to occur.

If the solid casing is intact and there is no flow in the annular space, the flow inside the casing may be stopped by installing a riser pipe before sealing an artesian well from bottom to top with sand-cement slurry.

Section 3.9 Well Abandonment/Sealing Report

Within 60 days after completion of the required work, the owner or operator of an abandoned well shall file with the commission a well abandonment/sealing report containing the owner's and operator's name and address, the water use permit number, if any, the name and address of the well driller who performed the work, the reason for abandonment/sealing, and a complete description of the work performed.

Section 3.10 Sealing Test Borings (Guidelines)

All test borings after their use has been completed must be abandoned and permanently sealed to protect ground-water resources from potential surface contamination. All obstructions that could interfere with effective sealing operations should be removed. The State Department of Health must be notified as soon as possible if pollutants or contaminants are known or suspected in the test boring.

Test borings should be completely filled with neat cement slurry from bottom to top in a manner that meets the objectives of the well abandonment/sealing section of these Standards.

Part 4.

PUMP INSTALLATION

Part 4.

PUMP INSTALLATION

Section 4.1 Pump Installation Permits

(a) General

No pump or pumping equipment shall be installed, replaced, modified, or repaired in a well without an appropriate permit, unless otherwise provided for in this section.

Within commission-designated water management areas (or aquifer systems), a pump installation permit to install a new pump or replace, modify, or repair an existing pump in a well may be approved by the chairperson if the applicant holds an approved water use permit for such a well. If no water use permit has been obtained, the commission must approve the application for a pump installation permit.

Within non-designated water management areas (or aquifer systems), a pump installation permit to install a new pump or replace, modify, or repair an existing pump in a well may be approved by the chairperson if the estimated actual water use totals less than 70% of the sustainable yield of the aquifer system in which the well is located. If the estimated actual water use totals 70% or more than the sustainable yield of the aquifer system in which the well is located, the commission must approve such application for a pump installation permit.

The replacement, modification, or repair of an existing permanent pump does not require a pump installation permit if such work does not exceed the existing pump capacity. However, in such cases, the well owner shall notify the chairperson in writing no later than the first working day after initiation of such work and within 30 days of completion of such work shall submit a completed pump installation report (Part II of Well Completion Report form).

Applications for a pump installation permit may be submitted for consideration concurrently with an application for a well construction permit, but will

be approved only after satisfying the conditions of the well construction permit. Applications shall be made on forms provided by the commission and shall be accompanied by a non-refundable filing fee, excepting government agencies, and shall be required for all areas of the state.

The chairperson shall approve or disapprove an acceptably completed pump installation permit application within 90 calendar days of receipt, unless it is filed concurrently with a well construction permit application. Each application shall contain the name of owner or operator; location; contractor's license number; purpose of pump installation; proposed withdrawal and use of water; water use permit information if applicable; type, size, and capacity of the pump; and such other information as the commission may require.

A pump installation permit shall be issued only if the proposed construction complies with all applicable laws, rules, and standards.

Every pump installation permit for an existing well without a pumping test meeting these Standards may require that a pumping test under these Standards be conducted. Measurements of time, pumping rate, drawdown, chloride and temperature content shall be recorded and reported as required in these Standards.

Every pump installation permit shall require the pump installation contractor to file a well completion report as required in these Standards.

The permit shall be prominently displayed at the site of the well at all times until the pump installation is completed.

An application for a pump installation permit whose application or amended application is rejected may obtain a hearing before the commission by filing within 30 days of the mailing of the notice of rejection a written petition requesting such a hearing. The hearing shall be conducted as provided in Chapter 13-167, "Rules of Practice and Procedure for the Commission on Water Resource Management."

The commission may modify, suspend, or revoke a permit, after notice and hearing, on any of the following grounds:

1. Material misstatement or misrepresentation in the application for a permit.

2. Failure to comply with the provisions set forth in the permit.
3. Willful disregard or violation of any provision of this part or any rule adopted pursuant thereto.
4. Material change of circumstances or conditions existing at the time the permit was issued.

Every pump installation permit issued shall be for a specified period not to exceed two years, unless otherwise specified in the permit and shall contain the commencement and completion dates for the permitted activity. In determining the commencement and completion dates of the activity, the commission shall take into consideration the:

1. Cost and magnitude of the project.
2. Engineering and physical features involved.
3. Existing conditions.
4. Public interest affected.

The chairperson may extend the completion date of the activity prescribed in the pump installation permit upon a showing of good cause and good-faith performance. If the commencement or completion date is not complied with, the chairperson shall cause the permittee to be notified by certified mail that the permit shall be revoked within 60 days unless the permittee can show good cause that it should not be revoked.

(b) Emergencies

When emergency alteration, repair, or replacement of a pump or pumping equipment, including the repair or restoration of structures damaged by a sudden and unforeseen event, is required to prevent or minimize loss of life, risk to public health and safety, or damage to property, a well owner may proceed to effect the emergency work without a permit. Such emergency work shall not increase, but may lower the existing pump capacity.

No later than the first working day after initiation of any emergency work, the well owner effecting the work shall notify the chairperson and describe the nature and circumstances of the remedial work so that the chairperson may issue an emergency authorization.

Within 30 days of notification to the chairperson the well owner effecting the emergency work shall submit to the chairperson a report describing the nature and extent of the emergency work performed, including relevant maps and diagrams showing the details of the work completed.

Section 4.2 General Installation Requirements

(a) Pumps and Pumping Equipment

All installations of pump and pumping equipment on wells should be constructed in such a manner as to prevent the pollution and contamination of the well from surface sources. All installations shall be designed and maintained so that the well, pump, and pumping equipment will be:

1. Designed within the well's pumping characteristics.
2. Installed in a weather and vermin proof manner.
3. Installed for operation without priming, excepting low head, nonpotable irrigation wells.

(b) Above-Grade Pump Connections

All pump installations shall be completed such that the top of the well casing extends a minimum of 12 inches above the prepared ground surface or pump house floor. Pumps may be installed directly onto the well casing and may be connected by threaded or welded joints, bolted flanges with rubber gaskets, or on a concrete platform constructed around the well casing.

For wells located in floodplains, the top of the well casing should extend at least two feet above the 100-year flood level.

(c) Water Suction Lines

Water suction lines from a well to a pump installed offset to the well should be installed a minimum of 12 inches above the ground surface or pump house floor. However, water suction lines may be installed below grade for use in manifold systems under negative pressures to connect a battery of low-head nonpotable, irrigation wells.

(d) Well Vents

All pump installations shall include a vermin-proof vent installed in the top of the well casing terminating at least one-half foot above the top of the casing, opening pointing downward and protected with a noncorroding metallic screen.

(e) Water-Level Monitor Tubes

Water-level monitor tubes may be required and made accessible for obtaining miscellaneous water-level measurements with a sounding or electronic probe.

Pump installations on water wells located in aquifers where the head is greater than 6.0 feet shall include the installation of a water-level monitor tube attached to the pump column, unless waived by the chairperson. The monitor tube shall consist of 1¼-inch diameter Schedule 80 PVC plastic pipe as listed in ASTM D1785 "Standard Specifications for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120," and shall be mechanically joined by square form flush joint threads (2 threads per inch) conforming to ASTM F480, or equal.

The bottom of the monitor tube shall be capped and submerged 20 feet below the planned drawdown in wells tapping high-level aquifers, or five feet below mean sea level in wells tapping basal aquifers. The bottom of the monitor tube, just above the bottom cap, shall be perforated with three horizontally drilled, equally spaced, 3/4-inch diameter holes. The top of the monitor tube shall be terminated with a threaded cap and a point which allows easy access for water-level monitoring.

The requirement for installation of a monitor tube shall be in addition to any airline pressure recorder assembly installed.

(f) Standards of Other Agencies

The published standards for vertical turbine pump-line shaft and submersible types of the American Water Works Association (ANSI/AWWA E101-88) and as may be amended are incorporated by reference as a part of these Standards. In addition to these Standards, pump and pumping equipment installations for wells to be used by the Water Department of the respective Counties of the State of Hawaii shall meet the standards specified in Volume I, Part III, Section 3 of "Water System Standards, State of Hawaii," 1985, and as may be amended.

Section 4.3 Lineshaft Turbine Pumps

(a) Mounting

Lineshaft turbine pumps may be installed directly onto steel well casings using a welded or threaded steel pipe flange with bolts and a watertight gasket, or bolted and sealed with a gasket onto a reinforced concrete platform constructed around the well casing so as to effectively seal the top of the well. All openings through the discharge head into the well constructed for airline and vent shall be sealed watertight with appropriate weather-resistant sealant or gasket.

(b) Concrete Platform

Concrete platforms shall be constructed so that the well casing projects at least one inch up into the pump discharge head. If the pump discharge head cannot extend down over the well casing at least one inch, a cast iron or steel subbase sanitary ring at least one inch thick shall be bolted to the base of the discharge head and centered over the well casing. A compressible neoprene gasket shall be installed between the base of the discharge and the sanitary ring unless the metal surfaces are machined. As an alternative, a flange may be welded to the top of the well casing.

(c) Lubrication

Water-lubricated lineshaft turbine pumps shall be used for potable wells. Water for lubrication of the pump shall be supplied from the potable water supply system. Water-lubricated lineshaft pumps are recommended for nonpotable wells. Oil-

lubricated lineshaft turbine pumps may be used for potable wells provided the oil lubricant conforms to USDA or FDA approved food contact grade formulations.

Section 4.4 Submersible Turbine Pumps

Submersible type turbine pumps may be installed directly onto steel well casings using a welded or threaded steel plate with bolts and a watertight gasket or bolted and sealed with a gasket onto a reinforced concrete platform constructed around the well casing so as to effectively seal the top of the well.

Section 4.5 Discharge Line Configurations

All discharge line configurations shall include an above-ground discharge line, an air-vacuum relief valve near the wellhead followed by a check valve, a tap for water sampling, and an approved water meter or other appropriate device or means for measuring and reporting total water withdrawal on a monthly calendar or work-schedule basis.

Section 4.6 Airlines for Water Level Measurements

Pump installations on wells may be optionally equipped with an airline assembly for the measurement of static and pumping water levels in the wells. The airline assembly shall include a 1/4-inch diameter galvanized iron or brass pipe or nylon tubing installed at a depth sufficient to accommodate the maximum planned drawdown in the well. The airline shall be securely strapped to the pump column throughout its length and the elevation of the bottom of the airline shall be accurately established and reported. The opening in the pump discharge head or pump base plate for the airline shall be constructed so that a weatherproof, watertight seal with caulking or gasket is obtained.

Section 4.7 Pump Installation Report

Within 60 days after the completion of a pump installation, modification, or repair, the pump installation contractor shall file with the commission the following:

1. Pump installation report (on forms provided by the commission).
2. As-built sectional drawing of the well and pump installation.
3. Pumping test record (if no pumping test conforming to these Standards has been performed).

Section 4.8 Water Use, Water Level, and Salinity Records

(a) Water Use

The owner or operator of any producing water well shall record the water use on a monthly basis, a work month or preferably a calendar basis. Water use records for all wells shall be reported in gallons per month based upon water meter readings.

(b) Water Levels

The owner or operator of a well shall measure and report static water levels in the well on a monthly basis unless the well owner or operator requests and the chairperson agrees that such monthly reports provide no significant hydrologic information. Static water levels shall be measured accurately to the nearest tenth of a foot.

(c) Salinity

The owner or operator of a well shall take grab samples and report the salinity of the well on a monthly basis or less frequently if the well owner or operator requests and the chairperson agrees that such monthly reports provide no significant hydrologic information. The salinity shall be reported as chlorides in milligrams per liter and shall be based on chemical titration methods or on electrical conductivity measurements calibrated against chloride titration data for the well.

(d) Frequency of Reporting Records

The frequency of reporting the monthly records shall be specified in the permit or by the chairperson.